OU.S. Patent Application Serial No. 10/82/1009
Filed: April 19, 2004, Inventor: Junes Wigger Larseo
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: Junes L. Ewing, IV, Telephone: 404,915,6494
Artorney Docket No. 14083/299978
REPLACEMENT DRAWING

## BEST AVAILABLE COPY

PAGE 10/35

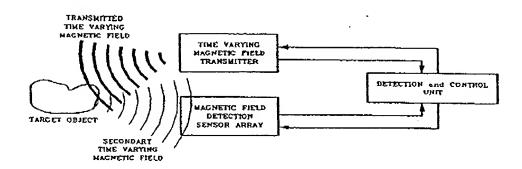


FIGURE 1-1 SYSTEM BLOCK DIAGRAM

U.S. Fatent Application Senal No. 10/327/089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, JV, Telephone: 404.815.6494.
Attorney: Docket No. 14088/29978
REPLACEMENT DRAWING

03/03/2006 15:23

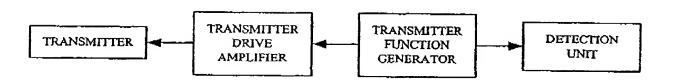


FIGURE 1-2 TRANSMITTER WITH KNOWN OUTPUT FUNCTION

Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Attorney Docker No. 14088/299978
REPLACEMENT DRAWING

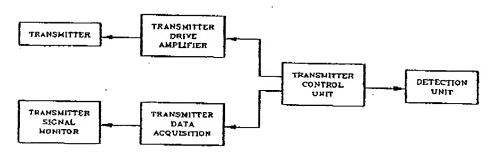


FIGURE 1-3
TRANSMITTER WITH MAGNETIC FIELD MONITOR

U.S. Patent Application Serial No. 10/827/089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Bwing, IV. Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

KILPATRICK\_STOCKTON

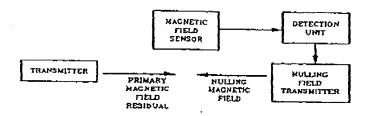


FIGURE 1-4A RESIDUAL MAGNETIC FIELD NULLING USING A NULLING MAGNETIC FIELD

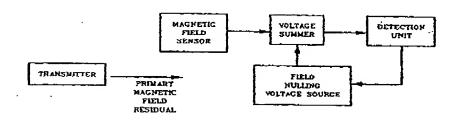


FIGURE 1-4B VOLTAGE NULLING OF RESIDUAL FIELD SENSOR OUTPUT

U.S. Patent Application Serial No. 10/827,089
U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Automey: James L. Ewing, IV. Tolephome: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

PAGE 14/35

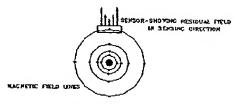


FIGURE 1-5A
TRANSMITTER COIL CROSS SECTION FOR SINGLE WIRE COIL
SHOWING SENSOR POSITION AND RESIDUAL FIELD

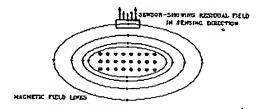


FIGURE 1-5B
TRANSMITTER COIL CROSS SECTION FOR NORMAL RECTANGULAR COIL SHOWING SENSOR POSITION AND RESIDUAL FIELD

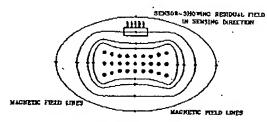


FIGURE 1-5C
TRANSMITTER COIL CROSS SECTION FOR SHAPED COIL SHOWING SENSOR POSITION AND RESIDUAL FIELD

03/03/2006 15:23 4048156118

Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
Apd/Or Location Of Various Materials
Attorney: James L. Ewing. IV. Telephone: 404.815.6494
Attorney: Docket No. 14038/299978
REPLACEMENT DRAWING

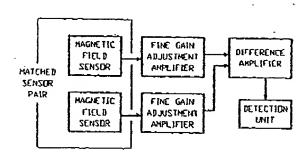


FIGURE 1-6
GRADIENT SENSING USING A MATCHED SENSOR PAIR

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004. Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence.
Apd/07 Location Of Various Materials
Attorney: James L. Ewing, IV. Telephone: 404,815,6494
Amoraey Docket No. 14088/299978
REPLACEMENT DRAWING

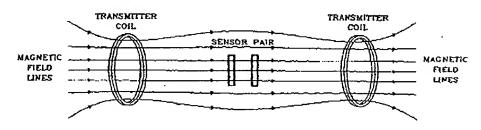


FIGURE 1-7
SENSOR PAIR CALIBRATION
USING TWO TRANSMITTER EQUAL COILS

PAGE 17/35

03/03/2006 15:23

4048156118

KILPATRICK\_STOCKTON
U.S. rement Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful Pur Detecting Presence
And/Or Location Of Various Materials
Autoroey: James L. Ewing, IV, Telephone: 404.815,6494
Attorney Docker No. 14088/299978
REPLACEMENT DRAWING

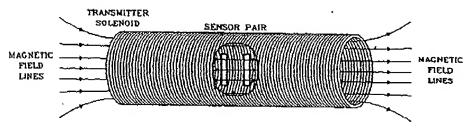


FIGURE 1-8 SENSOR PAIR CALIBRATION USING A LARGE SOLENOID COIL

U.S. Patent Application Serial No. 10/327,039
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV. Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

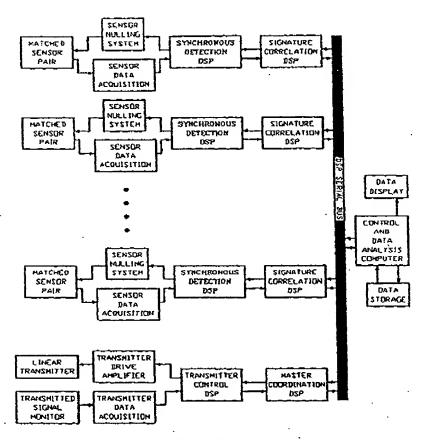
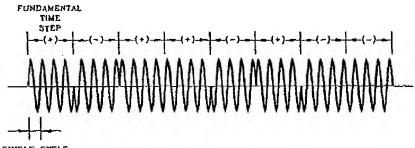


FIGURE 1-9
SYSTEM WITH MULTIPLE SENSOR PAIRS
AND SYNCHRONOUS DETECTION
BASED ON DSP PROCESSORS

1 13

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Joventon: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Antomey: James L. Ewing, IV. Telephone: 404.815.6494
Arromey Docket No. 14088/299978
RIPLACEMENT DRAWING



SINGLE CYCLE NOTE: AN INTEGER NUMBER OF CYCLES PER TIME STEP (4 IN THIS PATTERN)

FIGURE 1-10
AN 8 SECTION (+ - + + - + - -)
TIME ENCODED WAVEFORM

U.S. Patont Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wegner Larsen
For: Systems and Methods Useful For Detecting Presence.
And/or Location Of Various Materials
Automory: James L. Ewing, IV, Telephone: 404.815.6494
Automory Docket No. 14088/299978
REPLACEMENT DRAWING

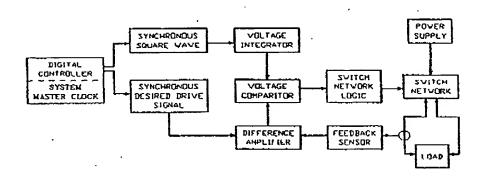


FIGURE 2-1
SYNCHRONOUS PULSE WIDTH MODULATION AMPLIFIER

U.S. Patent Application Serial No. 10/827,089
Füled: April 19, 2004, Inventor: James Wagner Lursen
For: Systems and Methods Useful For Detecting Presence.
And/Or Location Of Various Materials
Automory: James L. Ewing, IV, Telephone: 404,815,6494
Attorney: Docket No. 14088/299978
REPLACEMENT DRAWING

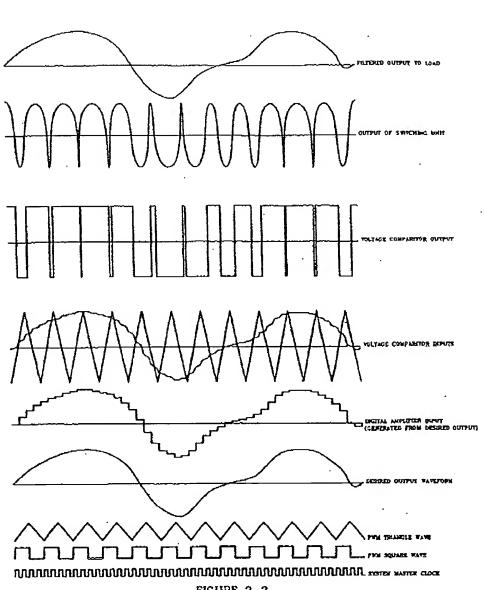


FIGURE 2-2
TYPICAL PULSE WIDTH MODULATION WAVEFORMS

PAGE 22/35

KILPATRICK\_STOCKTON
U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larson
For: Systems and Methods Use ful For Detecting Presence
And/Oy Location Of Various Materials
Atturney: James L. Ewing, IV. Telephone: 404.815.6494
Attorney Docket No. 14038/299978
REPLACEMENT DRAWING

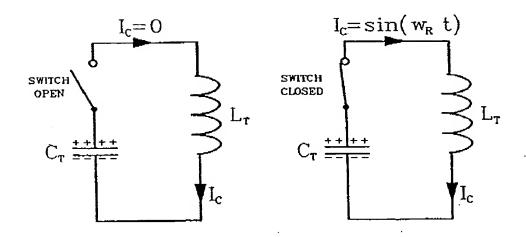


FIGURE 4-1 WHEN SWITCH IS CLOSED CIRCUIT OSCILLATES AT RESONANT FREQUENCY, WR

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Antorney: James L. Ewing, IV, Telephone: 404.815,6494
Attorney Docket No. 14088/259978
REPLACEMENT DRAWING

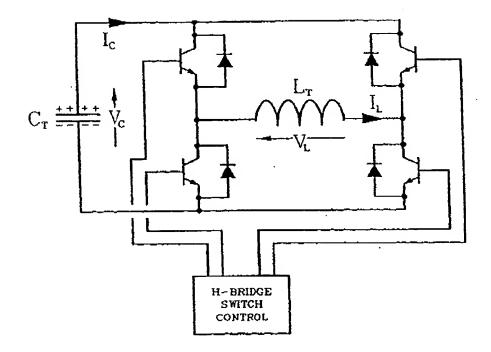


FIGURE 4-2
AN H-BRIDGE SWITCH NETWORK
CONNECTINT THE CHARGED CAPACITOR
TO THE LOAD COIL

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsep
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attomey: James L. Ewing, JV, Telephone: 404.815.6494
Attorney: James L. Ewing, JV, Telephone: 404.815.6494
Attorney: Docket No. 14088/299978
REPLACEMENT DRAWING

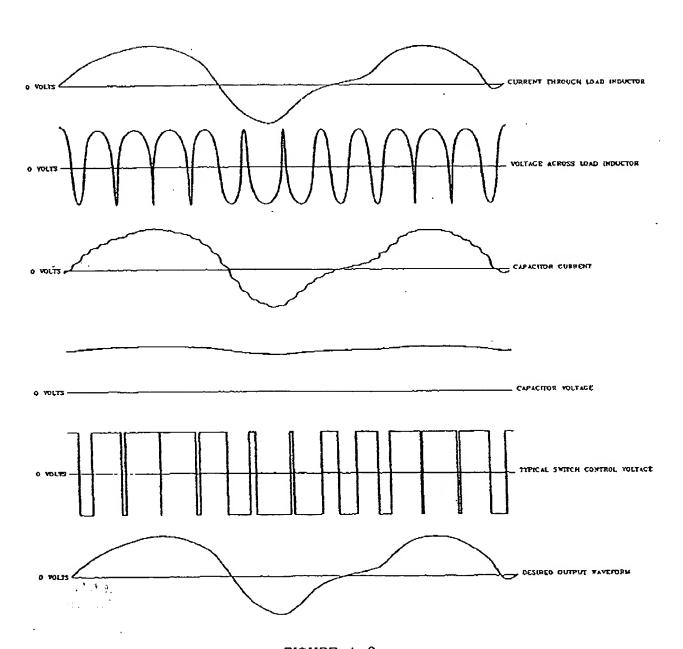


FIGURE 4-3
SWITCHED CAPACITOR CIRCUIT WAVEFORMS
PAGE 24/35 \* RCVD AT-3/3/2006 3:24:38 PM [Eastern Standard Time] \* SVR:USPTO-EFXRF-6/45 \* DNIS:2738300 \* CSID:4048156118 \* DURATION (mm-ss):05-42

U.S. Patent Application Serial No. 10827,089
Filod: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Antorney: James L. Ewing, IV, Telephonet: 404.815,6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

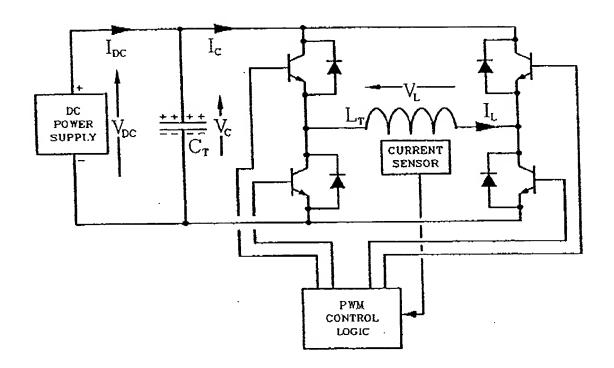


FIGURE 4-4
PULSE WIDTH MODULATED
SWITCHED CAPACITOR RESONATOR

U.S. Pstent Application Serial No. 10/827,089
Filed: April 19, 2004, Javentor: James Wagner Largen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone; 404.815,6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

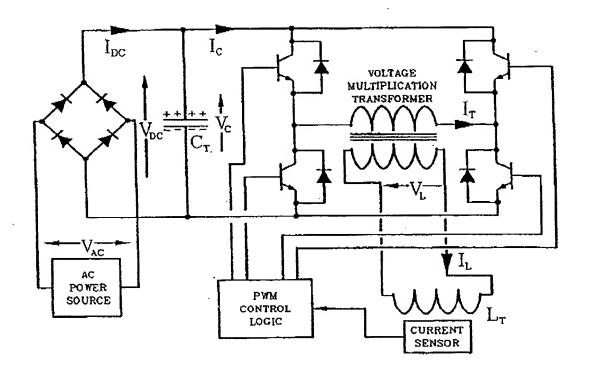


FIGURE 4-5 SWITCHED CAPACITOR RESONATOR WITH INTEGRAL SWITCHING POWER SUPPLY

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detocting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Antorney: Docket No. 14088/299978
REPLACEMENT DRAWING

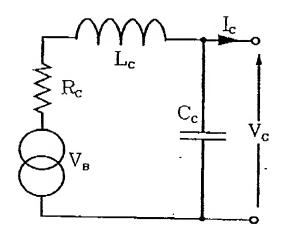


FIGURE 5-1 SENSE COIL EQUIVALENT CIRCUIT

KILPATRICK, U.S. Patent Application Serial No. 10/827/089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV. Telephone: 404.815.6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

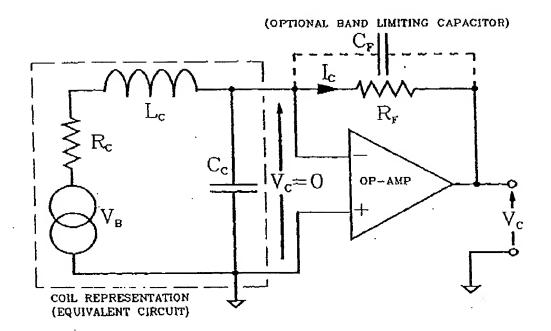
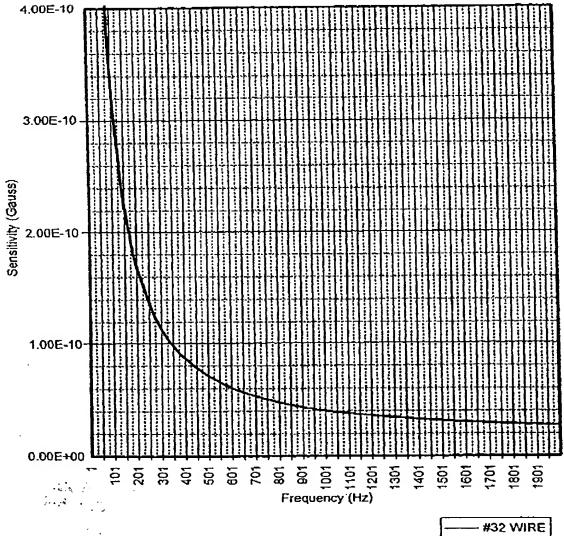


FIGURE 5-2
OPERATIONAL AMPLIFIER BASED
VOLTAGE TO CURRENT CONVERSION CIRCUIT

A: 10 .

U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: Juries L. Ewing, IV, Tekephanu: 404,815,6494
Amorrey Docket No. 14088/299978
REPLACEMENT DRAWING

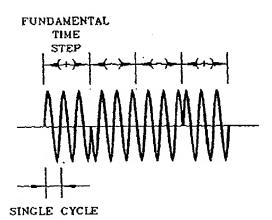
#### SENSITIVITY FOR #32 WIRE WITH Rf+10MOhm



#02 VIII.

4048156118

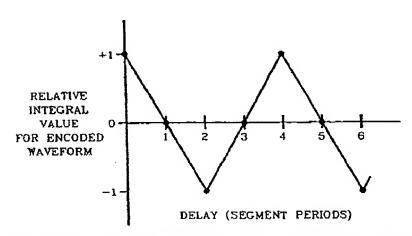
U.S. Patent Application Serial No. 10/827,039
Filed: April 19, 2004, Inventor: James Wagner Largen
For: Systems and Methods Useful For Detecting Presence:
And/Or Location Of Various Materials
Attorney: Jurnes L. Ewing, IV, Telephone: 404.815.6494
Attorney Docket No. 14084/299978
REPLACEMENT DRAWING



NOTE: AN INTEGER NUMBER OF CYCLES PER TIME STEP (3 IN THIS PATTERN)

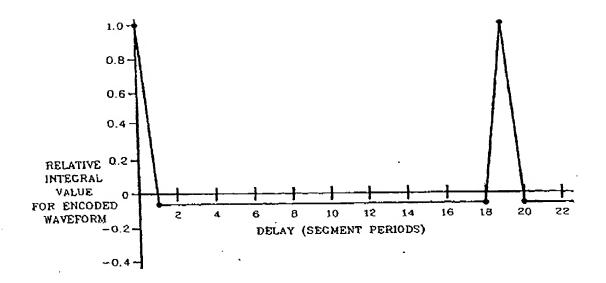
FIGURE 6-1 A 4 SEGMENT (+ - - +) TIME ENCODED WAVEFORM 4048156118

U.S. Parent Application Serial No. 10/827,039
Filed: April 19, 2004. Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Swing, IV, Telephone: 404.313.6494
Attorney Docket No. 14088/299978
REFLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-2 CORRELATION OF THE 4 SEGMENT (+ - - +) ENCODED WAVEFORM WITH ITSELF U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful Por Detecting Presence
And/Or Location Of Various Materials
Attorney; James L. Swing, IV, Telephone: 404,815,6494
Attorney Docket No. 14088/299978
REPLACEMENT DRAWING

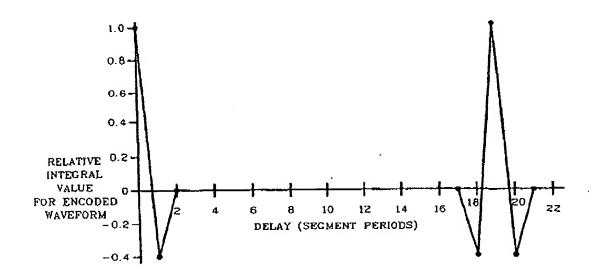


NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS 0.0526

FIGURE 6-3
CORRELATION OF THE 19 SEGMENT
(++++--++-+--)
ENCODED WAVEFORM WITH ITSELF

. . . .

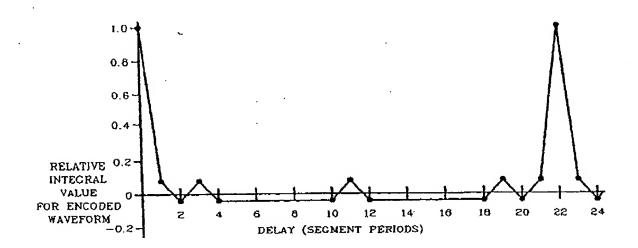
U.S. Patent Application Serial No. 10/827,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, 1V, Telephone: 404,815,6494
Amorney Docket No. 14088/299978
REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS -0.1

FIGURE 6-4
CORRELATION OF THE 20 SEGMENT
(+--++-+-+-+-+-)
ENCODED WAVEFORM WITH ITSELF

U.S. Patent Application Serial No. 10/327,089
Filed: April 19, 2004, Inventor: James Wagner Larsen
For: Systems and Methods Useful For Detecting Presence:
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV. Telephone: 404,815,6494
Attorney Docker No. (4088/299978
REPLACEMENT DRAWING



NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-5

CORRELATION OF THE 22 SEGMENT

(++++---+-+++--++)

ENCODED WAVEFORM WITH ITSELF

23 to 1 .

U.S. Patern Application Script No. 10/527,089
Filed: April 19, 2004, Inventor James Wagner Larsen
Fer: Systems and Methods Useful For Detecting Presence
And/Or Location Of Various Materials
Attorney: James L. Ewing, IV, Telephone: 404.815.6494
Autorney Docket No. 14088/259978
REPLACEMENT DRAWING

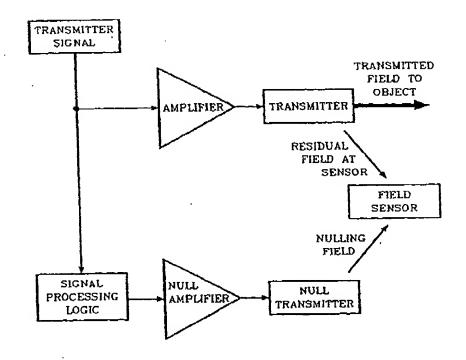


FIGURE 7-1 LOCAL MAGNETIC FIELD GENERATION FOR RESIDUAL FIELD CANCELLATION

# This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

### **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

□ BLACK BORDERS
□ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
□ FADED TEXT OR DRAWING
□ BLURRED OR ILLEGIBLE TEXT OR DRAWING
□ SKEWED/SLANTED IMAGES
□ COLOR OR BLACK AND WHITE PHOTOGRAPHS
□ GRAY SCALE DOCUMENTS
□ LINES OR MARKS ON ORIGINAL DOCUMENT
□ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY

### IMAGES ARE BEST AVAILABLE COPY.

☐ OTHER:

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.